

but that is only a part of a large whole. As stated elsewhere, it is too much to expect that pathologists become thoroughly versed in the intricacies of mycology; indeed, it is quite unnecessary. Such a center should have, however, at least one mycologic expert as departmental head, with one or two assistants and appropriate technical personnel as a beginning. To finance such a center I have only to cite the "Golden State"; the ability and materials which you have here are unsurpassed anywhere in the United States.

As we conclude, and look backward over the path we have traveled this morning, let us do it California-wise. Perhaps there are three eminences that dominate the landscape: first, the grumbling volcano "coccidioidal granuloma"; secondly, the butte "clinical"; and thirdly, the potentially commanding peak of all—laboratory examination." Equip the last, now, as a mycologic center and thereupon with the assistance of "butte clinical" you become dynamically commanding. Advances you are bound to make against coccidioidal granuloma and the other deep mycoses, if by no more than sheer effort, with your present forces; they will work much more efficiently, however, with the reinforcements added from a mycologic center.

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PULMONARY HEMORRHAGE*

AN INVESTIGATION OF THE EXCITING FACTORS IN TUBERCULOUS HEMOPTYSIS

Clinical Prize Paper of the Fifty-Ninth Annual
Session of the California Medical Association

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INTRODUCTION

PULMONARY hemorrhage is one of the most fearful and most frequent of the complications of pulmonary tuberculosis. According to Osler more than half of the patients with this disease suffer from some degree of pulmonary hemorrhage during the course of their illness. Since tuberculosis is responsible for nearly one-tenth of the average annual death rate, every twentieth person in this country suffers from hemoptysis from this cause at least once during his lifetime. It may appear as the first symptom in a person in whom the existence of tuberculous infection has never even been suspected, or it may occur as the last fatal event in a long-drawn-out struggle with chronic fibroid phthisis. Nevertheless, in spite of valuable work that has been done in the clinical, pathological, and experimental investigation of this phenomenon, pulmonary hemorrhage remains today nearly the mystery to the physician that it presents to the layman.

Pulmonary hemorrhage usually appears in the course of an advancing tuberculous process in the lungs, but why it appears when it does and under the conditions that usually prevail at that time is little understood. It is not a necessary consequence of the destructive lesion, since the tubercu-

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lous process is commonly preceded by thrombosis of the blood vessels before the tissue necrosis occurs. Thus it has even been observed that hemorrhage is even less likely to arise from an acute rapidly progressive type of disease than in the chronic fibroid cases. Perhaps some other exciting factor, in addition to the tubercle bacillus, is necessary to produce this manifestation. It is in the hope of elucidating some of the varied aspects of this problem that the present study has been undertaken.

FREQUENCY OF HEMOPTYSIS

During the past two and a half years, since May 15, 1927, careful record has been kept at the Olive View Sanatorium of Los Angeles County, of all pulmonary hemorrhages which have occurred among the patients there.* More than three thousand such hemorrhages have been so reported, arising among three hundred and thirty-three patients, or about 15 per cent of the more than two thousand patients who have been cared for in the institution for the whole or part of that time. This is somewhat lower than has been

TABLE 1.—Hourly Incidence of Hemoptyses

Hours	A. M.	P. M.	
12 - 1	82	102	
1 - 2	118	80	
2 - 3	98	78	
3 - 4	88	125	
4 - 5	87	110	
5 - 6	149	120	
6 - 7	252	138	
7 - 8	214	164	
8 - 9	137	127	
9 - 10	85	88	
10 - 11	83	96	
11 - 12	89	91	
Total	1482	1319	2801
No record			315
Total			3116

TABLE 2.—Daily Incidence of Hemoptyses

Day	Total	Average
Sunday	447	3.27
Monday	446	3.26
Tuesday	461	3.36
Wednesday	441	3.22
Thursday	426	3.11
Friday	439	3.21
Saturday	456	3.33
Total	3116	3.25

TABLE 3.—Monthly Incidence of Hemoptyses

Month	1927	1928	1929	Average
January	74	46	60	
February	103	24	63	
March	135	45	90	
April	112	111	111	
May	23	88	98	78
June	152	67	95	98
July	125	109	107	114
August	80	99	45	75
September	145	143	64	117
October	180	140	52	124
November	152	130	107	129
December	69	102	56	89
Total	964	1302	850	99 (3116)

reported elsewhere, but these patients have been under strict sanatorium regime, and many more of them had had hemorrhages before admission to the institution. As has been previously noted, tuberculous pulmonary hemorrhages are not uniformly distributed in time, but exhibit a marked tendency to occur in groups. An analysis of this periodicity may, perhaps, lead to a better understanding of the responsible factors.

* The name of the institution and other identifying references were lacking in the manuscript, but have been inserted by the editor.

DIURNAL VARIATION

The time of day at which the pulmonary hemorrhages occurred was obtained in about twenty-eight hundred instances, and tabulated according to the number of hemorrhages occurring in each hour. This showed a maximum during the hour six to seven in the morning, and another smaller peak from seven to eight in the evening. The morning peak shows three times as many hemorrhages during this one hour as during any hour of the night, and suggests that there must be some simple explanation for this preponderance.

The coughing that ensues when the patients arise from their sleep, in the effort to expel the secretions which had accumulated in the lungs during the night not only involves a considerable amount of movement of the lungs and other structures, with sudden marked changes in intrapulmonary pressures and stresses, but also increases the blood pressure, both in the systemic and the pulmonary circulation. The increased activity at meal time, which occurs at 6 a. m., noon and 5 p. m., rather than any physiological effect of the ingestion of food, may account for the increased number of hemorrhages at these hours. The lowest number of hemorrhages appear during the periods, both day and night, when the wards are quiet and the patients are supposed to be at complete rest. The varying curve of vital functions during the day, the relationships to the curve of temperature, pulse, and blood pressure are in accord with such a view. The diurnal changes in the barometric pressure, with maxima occurring in the morning and evening, may be of real significance, since, as shall be shown later, the barometric pressure appears to bear a direct relationship to the incidence of pulmonary bleeding.

Careful study of the relative incidence of hemoptyses on the different days of the week showed no consistent variation, any difference being well within the chance distribution of this array of data. The fact that visiting days are Sunday and Wednesday had no evident effect on the resultant pulmonary state, as shown in this data.

ANNUAL VARIATION

The periodicity of pulmonary hemorrhage is brought out again, however, when we consider the distribution at different times of the year. There is a definite maximum in the autumn, when the number of hemorrhages per day may average twice that prevailing at the time of minimal bleeding, in the winter. The fact that these seasonal variations do not concur with those reported by other workers in different places must be con-

TABLE 4.—Hourly Incidence of Deaths

Hour	A. M.	P. M.
12 - 1	40	33
1 - 2	31	34
2 - 3	35	45
3 - 4	23	46
4 - 5	37	42
5 - 6	48	46
6 - 7	46	37
7 - 8	47	37
8 - 9	46	33
9 - 10	46	23
10 - 11	43	34
11 - 12	46	31
Total	488	441 (929.)

TABLE 5.—*Daily Incidence of Deaths*

Day	Number
Sunday	86
Monday	78
Tuesday	77
Wednesday	70
Thursday	85
Friday	78
Saturday	81

Total, 555 deaths in 1096 days.

TABLE 6.—*Monthly Incidence of Deaths*

Month	1927	1928	1929	Average
January	17	16	16	16
February	14	18	19	17
March	23	13	12	16
April	22	17	17	18
May	11	15	15	14
June	18	17	15	17
July	17	14	9	13
August	10	21	14	15
September	15	16	11	14
October	15	17	12	15
November	21	12	14	16
December	12	7	22	14

Total, 555 deaths in 1096 days.

sidered in connection with the peculiar climatic conditions in this place. Thus the spring months, which have been stated to be accompanied by more hemorrhages in the East, are mild and equable in southern California, and lack the rigors of which other regions complain. The seasonal periodicity in the number of hemoptyses appears to be too great to represent merely a chance variation, and suggests a definite meteorological factor in the etiology of pulmonary hemorrhage. The various components concerned will be taken up in greater detail subsequently, but it may be noted that the autumn here is the period of the greatest variability of all of the meteorological factors in this vicinity, and it is, perhaps, the effort of the body to accommodate itself to these varying and abruptly changing states that induce the disturbance in physiological equilibrium resulting in hemorrhage.

VOLUME OF HEMOPTYSIS

The volume of the individual hemoptyses varied greatly, more than half of them being less than two ounces in bulk. It has been frequently stated that blood-streaked sputum and mere traces of blood should not be reckoned as of the same significance as a frank flow of blood, since fresh granulation tissue in the lung, tussive trauma, irritation of the postpharynx and larynx from hawking and spitting, etc., can produce these

TABLE 7.—*Amount of Hemoptyses*

Amount	Number
Not specified.....	264
Trace, streak or tinge.....	578
"Slight" or "clot".....	248
Less than one ounce.....	365
One ounce.....	495
Two ounces.....	434
Three ounces.....	245
Four ounces.....	156
Five to ten ounces.....	242
More than ten ounces.....	89
Total	3116

slight traces without denoting the actual rupture of a blood vessel, which is the cause of true tuberculous hemorrhage. The volume of nearly three thousand hemorrhages, as reported, indicates that more than a fourth of them were mere streaks, stains or slight blood clots, and that a third of them were measured as less than one ounce in volume. The 1661 hemorrhages of one

ounce or more included only eighty-nine more than ten ounces, and only ten more than sixteen ounces, or one pint, the amount generally given for a blood transfusion.

PERIODICITY

For the purpose of this study, only those hemorrhages involving one ounce or more of blood have been analyzed further. This is thought to correspond to what is generally referred to by writers on pulmonary hemorrhage in phthisis, and should repay analysis better than the indiscriminate gathering of all reports including those of blood-spitting of doubtful or absent significance. The hemorrhages have been treated as units according to the nurses' reports, thus if the same patient was reported as having three large hemorrhages during the same day, it was listed as three separate hemorrhages. Analysis shows that the number of patients who have hemorrhages each day bears a close relationship to the total number of hemorrhages that occur.

There were 1661 hemorrhages of one ounce or more reported during the 960 days from May 15, 1927 to December 31, 1929, inclusive, or an average of 1.73 a day. Actually, however, there were no hemorrhages at all or more than a third of these days, so that the average number of hemorrhages occurring on the days on which any did take place was 2.66. More than one-third of the hemorrhages reported occurred on less than one-tenth of the days included in this study, and half of them on one-sixth. This brings out sharply the fact of the marked "periodicity" of pulmonary hemorrhage in tuberculosis, and suggests that there may be some extrinsic factors rather than mere chance to explain the marked irregularity in the incidence of this phenomenon.

Nothing has been found in the conduct and regime of the sanatorium which might influence this condition. The number of patients in the institution at any time has not varied by more than 10 per cent during most of the period studied. Moreover, at no time is there record of a large number of patients being admitted who began to bleed immediately after their arrival. The appearance of the curve of incidence, showing that the peaks are scattered throughout the entire time involved and not gathered at any one occasion, dispels the idea that there may be a single or a few coincidental accidental factors that may be responsible. The relationship to visiting hours and the excitement attendant

TABLE 8.—*Frequency of Hemorrhages Per Day*

Number of Hemorrhages per day	Number of days	Total Number of Hemorrhages
0	336	0
1	213	213
2	156	312
3	104	312
4	60	240
5	31	155
6	26	156
7	18	126
8	8	64
9	2	18
10	4	40
11	0	0
12	1	12
13	1	13
Total	960	1661

upon them, since visitors are admitted only twice a week at the Olive View Sanatorium, is discounted by the fact that there appears to be little difference between the number of hemorrhages on different days of the week.

CLIMATIC DATA

Patients, attendants, physicians, and others, have repeatedly asserted that particular climatic conditions are associated with these periods of increased hemoptysis. The descriptions given of such weather conditions are quite vague and inconsistent. Pottenger's suggestion of the "electricity in the air" and Browning's conclusion that changeability rather than any particular static factor in the weather must be blamed, are the most tangible statements that have been discovered. In view of these widespread impressions, therefore, and in view of the relationship that they might have to the long-urged climatic treatment for tuberculosis, it was deemed advisable to inquire more carefully into the relationship of the incidence of pulmonary hemorrhage with the various climatic factors actually encountered at this institution.

TEMPERATURE

In anticipation of the possibility of some such study, data had been accumulated for several years under the direction of Dr. W. H. Bucher, superintendent of the sanatorium. This included a continuous temperature tracing for the entire period, from which daily minimum and maximum temperature readings have been made; wet and dry bulb thermometer readings made daily, about the middle of the day, in an outdoor location protected from wind, sun, and rain, from which the relative humidity or moisture saturation of the atmosphere has been calculated by the use of appropriate tables; daily barometric pressure readings made with a mercury barometer about the same time of day; and wind velocity measurements, made with an anemometer, and the tracing examined daily for the greatest number of miles of wind blowing in any hour of the day or night. It is with this data that we are now concerned.

The maximum daily temperature at Olive View Sanatorium varies from about 45 to 116 degrees Fahrenheit, but it is not above 110 or below 60 degrees more than ten days in the year, and lies between 70 and 100 degrees more than two-thirds of the time. The daily range of temperature is generally around 30 degrees, never being more

than 40 degrees and occasionally falling to as little as 10 degrees, especially in the winter time. In general, the greater is the maximum temperature the greater the daily variation, the minimum temperature never rising above 82 or falling lower than 40 degrees, true frost never appearing on the record of the past three years. Through the kindness of Mr. Bert Hanneman, these figures have been compared with the reports which he makes to the United States Weather Bureau from San Fernando, California, about four miles from the sanatorium. Although a few degrees difference in temperature often occurs between these two sets of figures, the general agreement, particularly in the direction and amount of change, is quite satisfactory.

Examination of the records for the maximum daily temperature, shows that the incidence of pulmonary hemorrhage is greatest on the days when the temperature is highest, and least when the temperature is around the theoretical optimum, about 70 degrees Fahrenheit, or perhaps when the temperature is lowest, since the differences here are inconsiderable. This accords with the fact that the least number of hemorrhages occur in the winter time here, as has been found also by Anders in Philadelphia, but not by some other writers; but the low summer figures show that it is the hot days of autumn, rather than those of summer, which are accompanied by bleeding from the lungs.

HUMIDITY

Popular impression credits increased humidity with a causal relationship in tuberculous hemoptysis, and patients are often warned to avoid fog or damp climates, or themselves complain of moist weather. The undoubted influence of moist weather conditions in rheumatic afflictions, however, may not be of equal importance in tuberculous hemoptysis. The lowest number of hemorrhages appeared to occur on the days of approximately optimum humidity, *i. e.*, between 50 and 60 per cent saturated, and both drier and moister days were associated with slightly higher figures. The differences are perhaps too small for any dogmatic conclusions, but suggest that the popular impression may have some basis but that it should be supplemented by recognition of the fact that deviations from the optimum of comfort in either direction may be associated with increased likelihood of pulmonary hemorrhage.

TABLE 9.—Maximum Temperature and Hemorrhages

Hemorrhages per day	Temperatures (degrees F.)					No Record	Total Days
	100	90-99	80-89	70-79	-69		
0	40	74	79	86	50	7	336
1	28	50	54	45	36	0	213
2	20	33	37	37	25	4	156
3	16	25	28	19	15	1	104
4	12	15	8	11	12	2	60
5	5	7	11	3	4	1	31
6	5	4	5	8	4	0	26
7	3	6	5	4	0	0	18
8	1	2	2	2	1	0	8
9	1	0	0	0	1	0	2
10	1	2	1	0	0	0	4
12	0	0	1	0	0	0	1
13	0	1	0	0	0	0	1
Total days....	132	219	231	215	148	15	960
Hemorrhages 267	401	402	327	240	24	24	1661
Average	2.03	1.83	1.74	1.57	1.62	1.6	1.73

TABLE 10.—Humidity and Hemorrhages

Hemorrhages per day	Per cent Humidity					No Record	Total Days
	70	60-69	50-59	40-49	30-39		
0	21	35	39	79	63	71	28
1	12	19	26	50	41	45	20
2	9	15	14	46	32	31	9
3	7	13	4	33	25	11	11
4	8	5	7	13	10	12	5
5	3	4	0	9	6	3	6
6	1	0	3	4	7	7	4
7	0	3	1	5	5	2	2
8	1	3	0	1	0	2	1
9	0	0	0	0	1	1	0
10	0	1	0	1	1	1	0
12	0	0	1	0	0	0	0
13	0	1	0	0	0	0	0
Total days..	62	99	95	241	191	186	86
Hemor- rhages....	112	196	131	415	346	294	167
Average..	1.80	1.98	1.48	1.68	1.81	1.58	1.94

The figures for wind velocity are, unfortunately, quite fragmentary, observations being available for only about half of the days studied. These appear to indicate a beneficial effect of mild breezes, the number of hemorrhages being higher on days of excessive calm, and least when the wind ranged between eight and fourteen miles an hour.

TABLE 11.—*Maximum Wind Velocity and Hemorrhages*

Hemorrhages per day	0-3	4-7	8-14	15-19	No record	Total
0	19	61	40	18	198	336
1	20	44	24	6	119	213
2	19	37	17	5	78	156
3	8	33	7	1	55	104
4	13	16	5	6	20	60
5	3	6	3	2	17	31
6	4	5	2	1	14	26
7	0	5	4	1	8	18
8	1	2	1	0	4	8
9	0	1	0	0	1	2
10	0	0	0	0	4	4
12	1	0	0	0	0	1
13	1	0	0	0	0	1
Total days.....	89	210	103	40	518	960
Hemorrhages	206	401	162	66	826	1661
Average	2.3	1.9	1.6	1.7	1.6	1.7

The results of these analyses of the temperature, humidity and wind velocity, therefore, appear to indicate that for each of these aspects of the weather there are optimum conditions under which the least number of hemorrhages may be expected to occur, but that marked variations from this optimum in any one of them, particularly in the direction of excessive heat or humidity, or absence of wind, are apt to be associated with an increase in the incidence of hemoptyses. It is important to note that we have been unable here to show any uniform relationship between these conditions themselves, except for the relatively greater frequency of hot, dry weather associated with strong winds.

BAROMETRIC PRESSURE

The relationship of barometric pressure to the incidence of pulmonary hemorrhage is of particular interest. It should be noted here that the popular impression that low barometric pressure heralds a rise in temperature, humidity and wind, and impending rain, is not true for conditions around Olive View; in fact, no constant or even predominant relationship between these weather components has been made out. Barometric pressure readings were usually made during the noon hour or in the early afternoon. The readings varied from 28.35 to 28.93 inches of mercury (735 to 720 millimeters), with an average of 28.65 inches (728 millimeters). Tabulation of the number of hemorrhages occurring on days of different barometric pressure reveals a striking relationship, more marked than any of the previous meteorological factors considered. Almost uniformly, the days with higher barometric pressure showed the greater number of hemorrhages, so that the days with the lowest barometric pressure had scarcely half as many hemorrhages as those on which the barometer rose the highest. Careful analysis of the data by statistical methods gave a positive coefficient of correlation of .11.

TABLE 12.—*Barometric Pressure and Hemorrhage (Same Day)*

Hemorrhages per day	-49	50-59	60-69	70-79	80-	No Record	Total
0	15	36	156	88	16	25	336
1	8	19	96	58	12	20	213
2	3	18	64	50	11	10	156
3	3	7	53	27	2	13	104
4	0	6	26	18	6	3	60
5	0	1	16	8	0	6	31
6	1	1	13	6	1	4	26
7	0	1	8	7	0	2	18
8	0	0	3	3	0	2	8
9	0	0	0	1	1	0	2
12	0	0	2	1	1	0	4
13	0	0	1	0	0	0	1
Total days..	30	89	439	267	50	85	960
Hemorrhages	29	119	770	479	89	175	1661
Average.....	1.0	1.4	1.8	1.8	1.8	2.1	1.7

TABLE 13.—*Barometric Pressure Preceding Day and Hemorrhages*

Hemorrhages per day	-49	50-59	60-69	70-79	80-	No Record	Total
0	10	40	151	85	7	43	336
1	15	15	106	59	13	5	213
2	3	13	72	49	11	8	156
3	1	10	43	35	8	7	104
4	1	7	26	20	3	3	60
5	0	2	17	6	2	4	31
6	1	3	11	8	2	1	26
7	0	0	9	5	2	2	18
8	0	1	3	4	0	0	8
9	0	0	1	0	0	1	2
10	0	0	2	2	0	0	4
12	0	0	0	1	0	0	1
13	0	0	0	1	0	0	1
Total days..	31	91	441	275	48	74	960
Hemorrhages	34	135	750	532	107	103	1661
Average	1.1	1.5	1.7	1.9	2.2	1.4	1.7

TABLE 14.—*Changes in Barometric Pressure and Hemorrhages*

Hemorrhages per day	Change in Barometric Pressure					No Record			Total
	15 to	10 to	5 to	4 to	-5 to	-10 to	-15 to	No Rec-	
0	14	12	42	151	38	17	10	52	336
1	11	9	20	109	25	7	3	29	213
2	2	7	23	68	26	7	7	16	156
3	1	2	8	51	12	6	5	19	104
4	4	4	12	20	7	5	2	6	60
5	1	1	5	12	2	1	0	9	31
6	1	2	4	6	9	1	1	2	26
7	0	1	1	8	3	1	0	4	18
8	0	0	2	5	0	0	0	1	8
9	1	0	0	0	0	0	0	1	2
10	1	0	0	3	0	0	0	0	4
12	0	0	0	0	1	0	0	0	1
13	0	0	0	0	0	1	0	0	1
Total days	36	38	117	433	123	46	28	139	960
Hemorrhages	64	69	210	700	238	90	46	244	1661
Average	1.8	1.8	1.8	1.6	1.8	2.0	1.6	1.8	1.7

CLINICAL DATA

The 1661 frank hemorrhages of one ounce or more, together with the 1455 other instances of blood-spitting reported, came from 333 patients of whom 183 were men and 150 were women. This male preponderance, which is the more significant since the sanatorium accommodates 20 per cent more women than men, is in accord with previous observers. More than 90 per cent of these patients were diagnosed "Far advanced pulmonary tuberculosis" at the time of admission, only two per cent entering in an incipient stage. Nevertheless the mortality rate in this group was exceptionally high; more than 34 per cent of them are already dead, and the 40 per cent who are still in the sanatorium are generally in a poor condition. It is worthy of note that not only are there more men who have hemorrhages, but that the mortality among the men in this series was

TABLE 15.—*Results in Hemorrhage Cases*

	Males	Females	Total
Died during hemorrhage.....	10	2	12
Died within a week.....	12	6	18
Died later in sanatorium.....	47	26	73
Died after discharge.....	8	3	11
Discharged and living.....	40	48	88
Remaining in sanatorium.....	66	65	131
Total	183	150	333

almost twice as high as that of the women. It has been stated that the Mexicans are a less tuberculous people and are less susceptible to the forms of tuberculosis which produce hemorrhage, but nearly a third of the patients in this series were Mexican. The men were, on the average, somewhat older than the women, but in both sexes all ages were represented, with the exception of children under twelve.

TABLE 16.—*Age Distribution of Hemorrhage Cases*

	Males	Females	Total
Under 20	25	28	53
20-29	66	65	131
30-39	43	43	86
40-49	32	8	40
50-	17	5	22
Total	183	150	333

TABLE 17.—*Clinical Classification of Hemorrhage Cases*

Stage on Admission.	
Minimal	7
Moderately advanced	20
Far advanced	306
Total	333
Condition on Discharge.	
Arrested	14
Improved	41
Unimproved	42
Dead	103
Remaining in sanatorium	133

LABORATORY DATA

Laboratory examinations were positive for acid-fast bacilli in the sputum in 90 per cent of the cases examined, at some time during their sanatorium stay, emphasizing the extent of the pulmonary pathology in this group. The Wassermann or Kahn test was either positive or doubtful in over 12 per cent, as compared to only 4 per cent in all patients at present in the institution, suggesting that lues may be a contributory factor in some instances, either to the advancing pulmonary pathology or perhaps to the final vascular lesion.

The white blood count in the hemorrhage cases averaged 12,000, which is about the same as that of the other far advanced patients now at this sanatorium. This may suggest that secondary infections by the pyogenic organisms is probably not an important factor in the production of these hemorrhages. The hemoglobin in these patients averaged well over 75 per cent, which is definitely higher than the corresponding figure for the other patients in this sanatorium. A decrease in hemoglobin during their stay in the sanatorium, however, was more frequent in this group than in the other patients treated here. We may conclude, therefore, that anemia is not a contributory cause of pulmonary hemorrhage, in fact, that plethora or a high concentration of the blood may be a more culpable factor, but that hemorrhage does tend, to a slight extent at least, to produce anemia.

The sedimentation time, as measured by a modified Linzenmeier technique, was below nor-

mal in nearly every instance and was less than thirty minutes in more than half of the cases, but was not as low at the time of admission as that of the far advanced patients who later had no hemorrhage. In nearly half of them, however, it dropped to a shorter time during their hospital stay, as compared to the other patients in the sanatorium, two-thirds of whom show a rise. This again suggests that the patients who had hemorrhages have a poor prognosis as a result, since a drop in the sedimentation time is of definitely poor prognostic significance.

TABLE 18.—*Laboratory Findings on Admission of Hemorrhage Cases*

Sputum.	
Acid fast bacilli found	298
Acid fast bacilli not found	35
Wassermann Test.	
Positive or doubtful	41
Negative	292
White Blood Cell Count.	
Under 10,000 per cubic centimeter	88
10,000-14,000	165
Over 15,000	80
Hemoglobin, per cent (Dare).	
Over 80 per cent	126
70-79 per cent	146
Under 70 per cent	61
Sedimentation Time (Linzenmeier).	
Under 15 minutes	54
15-29	127
30-59	95
Over 1 hour	42
No record	15

The blood pressure, measured at the time of admission, was below normal in most of these patients but somewhat higher than the figures obtained from other far advanced cases now in the sanatorium. On the other hand, nearly 10 per cent of them had a systolic pressure above 130 millimeters of mercury, which is more than twice the incidence of this finding in our admissions in general, and in a number of instances a marked hypertension was present. This association of high blood pressure with pulmonary hemorrhage may well possess pathogenic significance. To this extent the hypotension accompanying far advanced pulmonary tuberculosis may be looked upon as a homeostatic or protective mechanism. The coagulation time of the blood appears to be, if anything, more rapid than normal in our tuberculous patients, and examinations of patients with hemoptysis has thus far failed to reveal a single instance of undue prolongation of the clotting time.

TABLE 19.—*Blood Pressure in Hemorrhage Cases*

	Males	Females	Total
Under 100 millimeters	18	20	38
100-110	41	33	74
110-120	38	28	66
120-130	19	10	29
130-	20	10	30
No record	47	49	96
Total	183	150	333

MENSTRUAL FACTORS

The relationship of pulmonary hemorrhage to menstruation has been noted by a number of

TABLE 20.—*Menstruation and Hemorrhages*

Data available for 36 patients

Before menses	11
During flow	13
Following week	1
Intervening 2 weeks	4
Menses absent	7

writers. The fact that hemorrhages are, on the whole, less frequent and less serious in women than in men suggests that the menstrual phenomena may be, not a cause of hemorrhage, but rather a protection against it. This might act either by lessening the total volume of blood, thus relieving a plethora that might otherwise lead to hemoptysis by lowering the blood pressure or the basal metabolic rate, with lessening of the respiratory movements, or by increased coagulability of the blood, such as results from any loss of blood. The position that the hemorrhages that do occur occupy with respect to the menstrual cycle is not often stated, quantitatively, although individual opinions have been confidently expressed. For this reason the women now in the sanatorium were interviewed by a woman physician and any recollections they had as to the relationship of their hemorrhages to the time of menstruation was carefully recorded.

Examination of these reports showed a very definite relationship. In only one case did hemorrhage follow the menstrual flow, and in only four did it occur during the intervening fortnight. More than 85 per cent of the women reported that hemorrhage came either during a period of amenorrhea, or preceding or accompanying the first few days of menstruation. In several instances the observation was made that hemorrhage was apt to come at the time of suppression of menses, the so-called vicarious menstruation. Whether the hemorrhages so occurring depend on changes in the coagulability of the blood, on the engorgement of the mucous membranes of the lungs similar to the observed engorgement of the nasal mucosa, or on some specific expression of the female sex hormone is not known. The studies on the physiological monthly cycle in women, showing that the blood pressure reaches its maximum just before the menstrual flow, dropping to a minimum soon after the flow ceases and gradually rising to the maximum again, however, brings this phenomenon also in consonance with the fact that all of the other conditions resulting in increased blood pressure seem to be accompanied by pulmonary hemorrhage, while those lowering the blood pressure appear to afford some protection against it.

USUAL TREATMENTS

The therapeutic management of a case of pulmonary hemorrhage and the prevention of its recurrence depends upon our understanding of the pathological processes involved and the factors influencing them. The widespread idea that there is a delay in the clotting time has given rise to the prevailing treatment of pulmonary hemorrhage by calcium, fibrinogen, and other means of accelerating coagulation. The administration of emetin, ergot, adrenalin, and other vasoconstrictors have also been recommended in the apparent hope of producing a vasoconstriction that will hasten the clotting process in the lungs, or lessen the relaxation of the vessels in the lung which may allow such transudation of blood as has been

suggested by Otis. No support for any of these measures has been found in this study.

RATIONAL TREATMENT

More rational appears to be the use of vasodilators and depressants. Even though the blood pressure in these patients may not be as high as normal, relative lowering of the pressure may make for more easy clotting and retention of the clot. That transient increases in the blood pressure may play an etiological rôle in the causation of pulmonary hemorrhage is suggested by many facts. Hemorrhages following sudden or unusual exertion may be reported by any physician with experience with tuberculosis. The rôle of emotion, excitement and anxiety, all of which increase the blood pressure, have been noted many times. More tangible, perhaps, is the data showing that in the morning, when patients arise and the blood pressure rises from the low sleeping level to the higher waking one, the incidence of hemorrhages multiplies several times. The lowering of this incidence during the afternoon rest period, and its increase thereafter, also fits in with this explanation. It is highly probable that the effect of meteorological conditions on the frequency of hemoptysis may be found to act through this mechanism. All experimental evidence indicates that diminished barometric pressure lowers the blood pressure, and vice versa. It is possible that the diurnal barometric maxima have also their relationship to the daily fluctuations in the blood pressure. The greater incidence and severity of pulmonary hemorrhage in men, as compared to women, may be explained by the lower blood pressure in the latter group. The frequency with which hemorrhages when they do occur in women come just before or at the beginning of the menstrual period, when the blood pressure is highest, or during suppression of the menses, when it may also be expected to be unduly increased, may be attributed to the same agency.

PULMONARY APOPLEXY

A comparison may be made between pulmonary hemorrhage, or hemoptysis, and cerebral hemorrhage, or apoplexy. Both result from pathological conditions in the region of the vessels affected, such as arteriosclerosis in the cerebral vessels or tuberculosis in the lungs. In addition, both are precipitated by sudden and abrupt increases in the blood pressure, as from excitement, exertion, etc. The analogy is not yet complete, but the possibility should be borne in mind and may well repay further study.

It has not been possible at this time to take up all of the interesting angles to the clinical study of pulmonary hemorrhage. It is hoped, however, that the many relationships here shown or suggested may be further investigated so that we may better understand, and thus more successfully forfend, this intimidating visitation.

APPENDIX—COMMENT

Death Data.—At the same time that the study of hemoptyses was being conducted, data was

accumulated regarding the 929 deaths which have occurred here since the opening of the sanatorium of which 555 have taken place within the past three years. The hourly curve of death shows that, contrary to the popular impression, the majority of deaths from tuberculosis occur during the waking hours, the largest numbers occurring in the morning after arising, and in the afternoon after the rest period. The differences are not nearly so marked as in the case of the hemorrhages, however, and do not point so directly at some causative factor. Only twelve deaths have resulted immediately from a hemorrhage, and eighteen more within a week thereafter, during the past three years, and less than one-fourth of the patients dying here had hemorrhages while they were in the sanatorium.

The weekly fluctuation in the death rate from day to day is inconsequential, the apparently slightly lower figure for Wednesday having no clear significance. The seasonal variation in the death rate is surprisingly low, the average of fifteen deaths a month having been maintained for several years with only slight occasional variations. This is especially unexpected in view of the marked seasonal variation in the death rate from other respiratory infections.

Barometric Analysis.—It was suggested, however, that the barometric pressure effect might not be manifested at once, however, but only after a number of hours, and that, in any case, the hemorrhages occurring at the time of the peak, in the morning, were more likely to be influenced by the barometric pressure reading taken the day before than by one which was not taken until many hours later. The number of hemorrhages per day, therefore, were recalculated with reference to the barometric pressure existing on the previous day, and the data again analyzed. The value of this manipulation was at once evident.

The days when the barometric pressure rose to 28.8 inches or higher were followed by an average of 2.2 hemorrhages per day, while the days when it dropped to below 28.5 inches were followed by an average of only 1.1 hemorrhages per day. The intermediate figures show corresponding relationships. In other words, whenever the barometer is low we may expect few hemorrhages; whenever it is high, more on the succeeding day, and intermediate conditions yield intermediate numbers of hemorrhages. If we try to continue this process further still, however, and correlate the number of hemorrhages with the barometric pressure on the second preceding day, this relationship is lost and no connection between barometric pressure and hemorrhages appears.

Many previous workers have considered that the change and the direction in change of the barometric pressure, rather than the absolute values of the pressure existing, are of significance in the incidence of pulmonary hemorrhage, as has been stated by Browning and Pottenger. Our data lends but little support to this conception.

The days with little or no change in the barometric pressure do seem to have somewhat fewer hemorrhages than those with more change in the barometer, but the difference is slight and there appears to be no significance at all as to whether the barometer is rising or sinking.

This unexpected phenomenon, that the incidence of pulmonary hemorrhage goes hand in hand with the height of the barometric pressure is the most definite and unambiguous finding in this investigation. It is unfortunate that the data from previous studies so far encountered has not been so presented as to make direct comparison possible. It is hoped that further attempts will be made to see if this apparent relationship holds in other places and at other times.

Olive View Sanatorium.

SAFETY MEASURES IN THE PRACTICE OF UROLOGY*

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IN recent years urology has made great strides and is considered today as the specialty in which diagnosis has reached a greater state of perfection than in any other branch of medicine. The development and perfection of the diagnostic and operative cystoscope has provided a method of precise examination and accurate treatment of diseases of the kidney, ureters, and bladder. The mortality attending all surgical interventions on the urinary tract has been greatly reduced. These advances have been due to complete supervision and treatment of urinary disorders by the highly trained specialist of the day—the urologist—who is able to diagnose any lesion of the urinary tract, to perform any operation on the urinary organs that is necessary, and to cope with any complication that might arise. In spite of the great perfection that our specialty enjoys, certain established procedures are continued which are harmful, sometimes even fatal to the patient, which seemingly are continued, not because of lack of safer methods or of condemnation voiced by individual urologists who have had embarrassing or fatal accidents, but by virtue of time-honored custom. It is the purpose of this address to review and condemn these dangerous procedures, substituting harmless and efficacious methods in their place.

LOCAL ANESTHESIA

In producing surface anesthesia of the urethra and bladder prior to instrumentation and cystoscopic investigation, cocaine is still used. There is no doubt that it produces excellent analgesia, but it is dangerous, particularly in the aged, and when there are open bleeding or ulcerative surfaces in the urethra and bladder. Should it come in contact with an open surface, rapid absorption takes place, leading to grave symptoms and sometimes

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